## REMARKS

### I. Introduction

In response to the Office Action dated September 25, 2008, which was made final, and in conjunction with the Request for Continued Examination (RCE) submitted herewith, claims 1 and 15-18 have been amended. Claims 1-26 remain in the application. Re-examination and re-consideration of the application, as amended, is requested.

### II. Non Prior-Art Rejection

On page 2, claims 1-26 were rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement. Specifically, the Office Action states that there is no antecedent basis for "Group III-nitride" in the original disclosure.

Applicants' attorney has amended the claims to overcome this rejection, but nonetheless respectfully traverses this rejection. Applicants' specification, for example, at page 6, lines 23-24, refers to an LED fabricated from (B, Al, Ga, In)N, and the term "Group III-nitride" is well known in the art as an equivalent to "(B, Al, Ga, In)N." However, in order to expedite prosecution, Applicants' attorney has replaced the term "Group III-nitride" in independent claims 1, 17 and 18 with "(B, Al, Ga, In)N."

### III. Prior-Art Rejections

#### A. The Office Action Rejections

On page 2, the Office Action rejected claims 1-26 under 35 U.S.C. §102(b) as being anticipated by or, in the alternative, under 35 U.S.C. §103(a) as being obvious over Palacios et al., S.S.T. 15 (2000) pp. 996-1000 (Palacios). On page 3, the Office Action rejected claims 1-26 under 35 U.S.C. §103(a) as being obvious over Palacios with Wong et al., APL 10/2000 Vol. 77 No. 18 pp. 2822-2824.

Applicants' attorney respectfully traverses these rejections.

#### B. The Applicants' Invention is Patentable Over the References

The Applicants' invention, as recited in independent claims 1, 17 and 18, is patentable over the references, because the independent claims contain limitations not taught by the references. Specifically, none of the references, taken individually or in combination, teach or

suggest the limitations of Applicants' amended independent claim 1 that recite "wherein light from an emitting layer is extracted through a surface of the nitrogen face (N-face) of the LED and the surface of the N-face of the LED is structured to enhance extraction of the light out of the surface," the limitations of Applicants' amended independent claim 17 that recite "structuring the surface of the N-face after growth to extract light out of the surface," or the limitations of Applicants' amended independent claim 18 that recite "a nitrogen face (N-face) surface of the n-type layer is structured after growth, so that light from the active region is extracted through the structured N-face surface of the n-type layer."

The Office Action, however, asserts the following:

> Claims 1-26 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Palacios et al., S.S.T. 15 (2000) pp. 996-1000.
>
> Palacios discloses N-face GaN structure with etched pyramid structures enabling better light emission. Palicios discloses this structure useful for LEDs. The GaN layers were grown on silicon substrate. Claim 1 is anticipated or at least obvious over Palacios depending on one's interpretation of "structured". The etched N-face of the Palacios light emitting device is considered "structured". Other claims are rejected as the product by process language does not distinguish the final product over Palacios. See the previously recited caselaw. The method claims do not distinguish over Palacios because he practices the same method of etching with KOH.
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> Claims 1-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Palacios with Wong et al APL 10/2000 Vol. 77 No. 18 pp. 2822-2824.
>
> Palacios discloses better light emitting leds with wet etching of the N-face GaN to produce pyramids. Wong discloses GaN based led structure with specific silicon substrate and SQW structure for top metal contacts, silicon integration and monolithic optimization. It would have been obvious to have practiced N-face GaN based leds on silicon substrates with pyramidal cones and SQW structure from the suggestions of both references in order to extract more light out of the leds than prior art structures and to optimize integration with silicon circuitry. Applicant's claims are obvious structure. The method claims are likewise obvious as Wong discloses LLO.

Applicants' attorney respectfully disagrees with this analysis.

The abstract of Palacios describes wet etching for the "fabrication of high optical quality pyramidal nanostructures in wurtzite N-face GaN grown on AlN-buffered Si(111) substrates by molecular beam epitaxy." The body of Palacios describes two different batches of samples: Set A consists of GaN layers grown on a thin (10-20 nm) AlN buffer, whereas Set B consists of GaN

layers grown on thicker (30-50 nm) AlN buffers (Palacios, page 996, column 1). However, the GaN layer in Set A comprises a mixed N-face/Ga-face layer, while the GaN layer in Set B comprises only Ga-face (Palacios, at page 999, column 1). Thus, Palacios actually describes etching a mixed N-face/Ga-face GaN layer, rather than an N-face GaN layer.

The result of this etching of the mixed N-face/Ga-face GaN layer in Palacios comprises monocrystalline pyramidal defect free nanostructures limited by {11-21} planes (Palacios, page 998, column 1). Palacios states that these structures result in an increase in photoluminescence (PL) intensity for the layer: "… the PL peak in A-type samples shifts to higher energy," "… the PL intensity is significantly enhanced with the etching time," and "[t]he energy shift and intensity enhancement can be explained by the relaxation of tensile strain during the formation of the pyramids" (Palacios, at page 998, column 2). Thus, the etching of Palacios improves light emission from a light emitting layer.

Applicants' independent claims, on the other hand, structure the surface of an N-face of an LED to enhance light extraction out of the surface. There is no teaching or suggestion that the etching performed by Palacios creates structures that enhance light extraction out of the surface. Instead, the etching performed by Palacios merely improves the PL intensity, i.e., light emission, of an emitting layer.

In addition, Applicants' attorney respectfully submits that such a light extraction function is not inherent in Palacios' structures. M.P.E.P §2112 states that, in order to establish inherency, extrinsic evidence must make clear that the missing descriptive matter is necessarily present in the thing described in a reference, and that it would be so recognized by persons of ordinary skill. In this case, there is no extrinsic evidence that would suggest that the etching performed by Palacios results in structures that are capable of enhancing light extraction from an N-face surface of an LED, rather than merely improving PL intensity within an emitting layer.

It is first noted that Palacios does not describe an LED structure. Instead, the structure described in Palacios is merely GaN doped with Si on an AlGaN buffer layer on a sapphire substrate. In Palacios, the GaN is a thick slab 0.5 - 2 microns thick (Palacios, page 997 ,column 1), which is about 1000 - 10,000 thicker than a quantum well.

In Palacios' structure, light is emitted from everywhere within the volume of the GaN slab, and that light impinges on the surface of Palacios' structure with a large range of angles of incidence, which renders the light less sensitive to surface conditions. This means that surface

roughening in Palacios should have a negligible effect, if any, on light extraction. On the other hand, light emission in an LED structure is more localized and confined by the geometry, such that the emitted light impinges on the surface of the LED with a much smaller range of angles of incidence, which means that surface structuring enhances light extraction.

Finally, the size of Palacios' pyramids is 50 nm, which is too small to improve the light extraction efficiency (Palacios, page 998, Figure 4(a)). In order to extract light, the size of the structures should be at least the size of the wavelength of the light emitted by the LED:

> Applicants' specification: page 11, line 20
> The cone-shaped surface appears very effective for light extraction from the LED. Moreover, experimental results suggest that a cone shape can extract more light. **For example, the wavelength of a blue LED in a GaN crystal is about 200 nm. If the size of the cone shape is much smaller than that value, then the light might not be affected by the roughness.** On the other hand, if the size of the cone shape is close to that value, the light might be scattered or diffracted.

Thus, Palacios' pyramidal nanostructures would have a negligible effect, if any, on extraction of emitted light.

In summary, the structured N-face surface of the LED in Applicants' invention enhances light extraction, while the etching performed by Palacios merely improves the PL intensity or light emission of an emitting layer. Thus, Palacios is directed to an increase in internal quantum efficiency for the emitting layer, whereas Applicants' claims are directed to an improvement in light extraction efficiency for the LED. Consequently, Palacios does not teach or suggest all the limitations of Applicants' claims.

Wong fails to overcome the deficiencies of Palacios. Wong merely describes a GaN based LED structure. Palacios combined with Wong is, again, limited only to etching emitting layers (e.g., Wong's InGaN single quantum well layer) to improve their PL intensity, not structuring an N-face surface of the LED to enhance light extraction from the surface. Consequently, the assertion by the Office Action that Palacios combined with Wong teaches the Applicants' invention is erroneous.

Thus, Applicants' attorney submits that amended independent claims 1, 17 and 18 are allowable over the references. Further, dependent claims 2-16 and 19-26 are submitted to be allowable over the references in the same manner, because they are dependent on the

independent claims, and thus contain all the limitations of the independent claims. In addition, dependent claims 2-16 and 18-26 recite additional novel elements not shown by the references.

IV. Conclusion

In view of the above, it is submitted that this application is now in good order for allowance and such allowance is respectfully solicited. Should the Examiner believe minor matters still remain that can be resolved in a telephone interview, the Examiner is urged to call Applicants' undersigned attorney.

Respectfully submitted,

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